Space Weather Technical Forecast

Issued on Wednesday, 31 July 2024 at 13:17 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: CME arrivals expected, most likely Day 1 (31 Jul), with G1-G2 Minor to Moderate storms likely and a slight chance of G3 Strong Storms. Ongoing risk of M-class and X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate, five M-class flares have been observed from across the disc, with the strongest a M9.5 at 30/1938 from AR3772. A highly active disk with fourteen active regions, including four with delta magnetic configurations. This includes AR3768 in the far southwest, which continues to display a delta spot to the north of one of its intermediates although this region becoming increasingly difficult to view. AR3770 in the west-center disk, persists as a compact region with a small but relatively strong delta spot to its north, and with some indications of further potential flux emergence. AR3765, AR3766 and AR3767 make up a cluster of spots in the southwest disk. AR3765 is the largest, containing a delta spot as part of its intermediate spots. AR3766, appears to have recently lost its delta spot in its trailing region. AR3767 is a comparatively simpler region situated in very close proximity behind AR3765. AR3773 has also recently emerged west of the main cluster. Newly numbered AR3772 on the far east limb may also have a small delta spot on its leader, although confidence is low due to the oblique viewing angle. A large region as yet unnumbered is just appearing over the eastern limb and appears to show significant magnetic looping. Finally two new regions has emerged in the northeast disc and are yet unnumbered, for now appearing small and magnetically simple.

A fast CMEs associated with the M9.5 flare from AR3772 has been assessed as contributing to the risk of a glancing blow into 02 Aug although further modeling ongoing. We await model data on a narrow CME observed leaving the southwest disk approximately 31/0120UTC and a larger partial halo CME observed moving to the west remains under investigation.

Solar Wind / Geomagnetic Activity: The solar environment has been under waning CME influences over much of the last 24 hours due to a CME arrival at L1 late on the 29th. Solar winds speeds, as measured by ACE at L1, showed a slow decline from around 500km/s to finish the period at around 400 km/s, though a slight uptick to around 430km/s from 31/1040UTC may signal a further CME arrival. Density was initially average, before declining to below average through the period, though once again an increase to average levels from 31/1040UTC. The Interplanetary Magnetic Field, Bt, was initially moderate, but slowly declined weak levels, around 6nT before a sharp increase back to a peak of 9nT at 31/1040UTC. The north-south component, Bz, was weak throughout +5/-5nT. The resulting Geomagnetic activity was Quiet to unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background throughout. High energy electron flux (greater than 2MeV) observed at GOES16 was also at background. The 24-hour fluence was below the Active threshold with 1.39e6 integrated pfu observed at 31/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected with occasional M-class flares expected and chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: A number of CMEs have the potential to arrival through the period. The CMEs from the M9.9 early on 28 Jul, and then the M2.6 and long period M1.7 later on 28 Jul are expected to combine to give a single arrival sometime on Day 1 (31 Jul), perhaps already ongoing. Further CME arrival is then possible on Days 2-3 (01-02 Aug), chiefly from the M8.7 flare on 29 Jul. No coronal hole fast wind enhancements are expected, with CME arrivals expected to dominate, bringing spells of slightly elevated to elevated winds, and likely periods of Active to G1-G2 Minor to Moderate Storm conditions. There is a slight chance of G3 intervals, mainly Day 1 (31 Jul).

Energetic Particles / Solar Radiation: High energy proton flux is currently at background. Should any notable flares occur in the western disk there is a likelihood of this increasing above background, with a chance of exceeding the S1/Minor Storm threshold. This is due to the increasingly geoeffective location of the sunspot regions in this area. The high energy electron flux is forecast to be mostly at background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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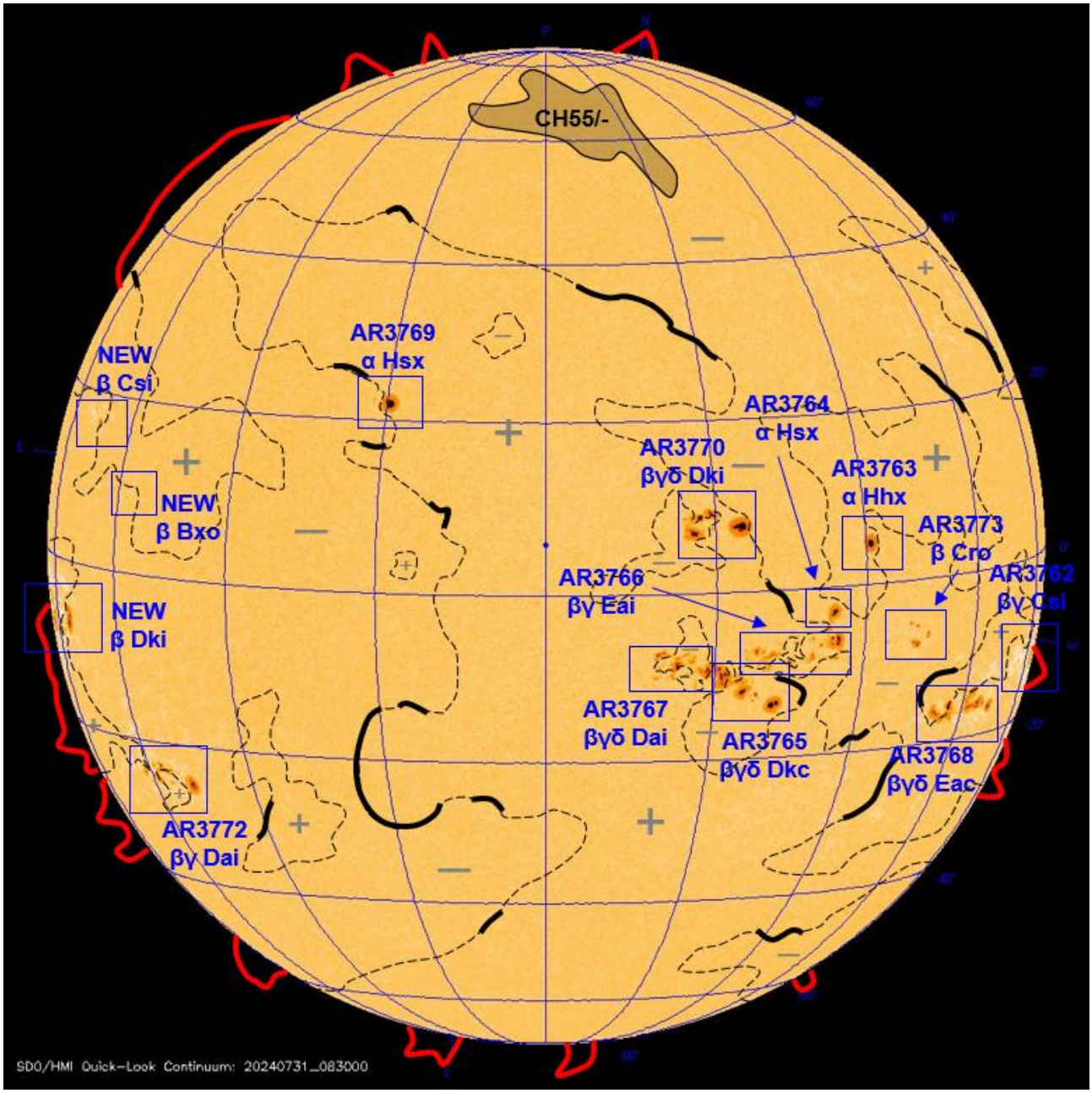
Figure 1. Solar Analysis Valid 31/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Current CME influence from the arrival on the 29th July is expected to ease, however there are further Earth-directed CMEs that are expected to arrive through this period.

The first is a halo CME from the M9.9 from AR3766 on 28/0200 UTC, but likely mainly shock with limited material. The second is a partial halo from the combination of the M2.6 at 28/1250UTC from AR3762 and the long duration M1.7 at 28/1422 UTC from AR3768, off the southwest disc. This second CME is faster than the first, with both likely combining to give a single arrival on Day 1 (31 Jul), perhaps already ongoing. Timings are low confidence however, due to contamination from other CME's occurring off the Earth-Sun line, and some poor imagery quality.

Further CME arrival is then possible on Days 2-3 (01-02 Aug), chiefly from the M8.7 flare at 29/1255 UTC from AR3762 and the dimming that occurred to the north of the region. This is low confidence, however with a glancing impact most likely. Furthermore, due to the number of coincident CMEs, including those off the Earth-Sun line, analysis has been more difficult than usual. Consequently further weaker arrivals also cannot be ruled out through the period.

No coronal hole fast wind enhancements are expected, with CME arrivals expected to dominate the next few days. These are likely to bring periods of Active to G1-G2 Minor to Moderate Storms into the start of the period before conditions slowly easing. There is a slight chance of G3 intervals, mainly Day 1 (31 Jul).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	60	30	5
Strong	G3	No	20	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0808	Asymmetric Full	M9.9(AR3764)	03W 04S	598 km/s	31/0300 -6/+12hrs	Low confidence. Likely combined arrival with below
28/1838	Partial	M2.6(AR3767) /M1.7(AR3768)	18W 08S	747 km/s	31/0300 -6/+12hrs	Low confidence.
29/1832	Partial	M8.7(AR3762)	20W 37N	701 km/s	01/1400 +/- 12hrs	Low confidence.

Figure 2: Latest MOSWOC ENLIL Ensemble output, showing multiple potential impacts in the coming days and a high degree of uncertainty.

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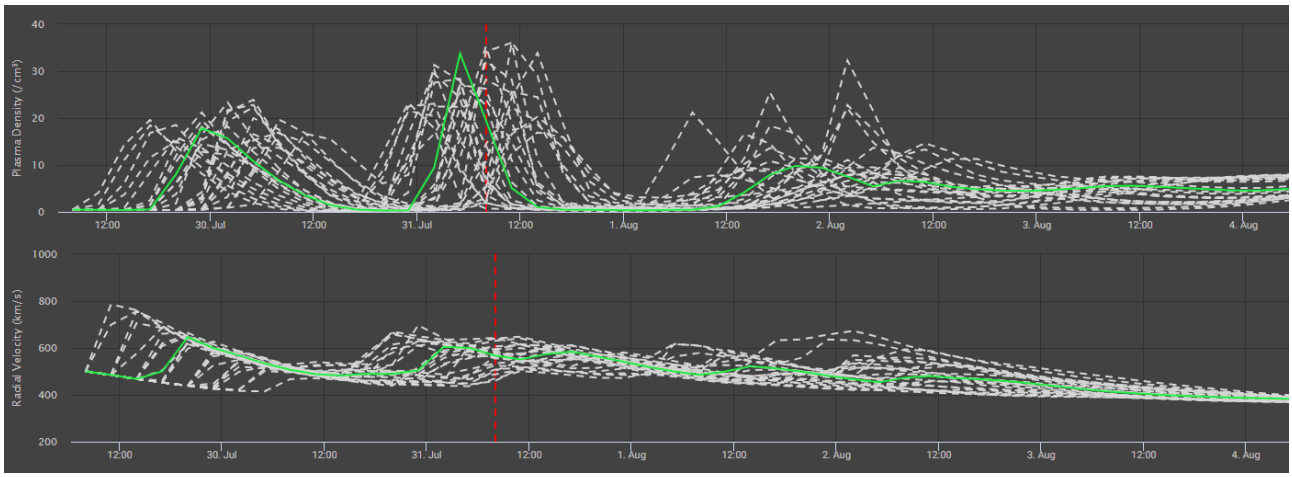

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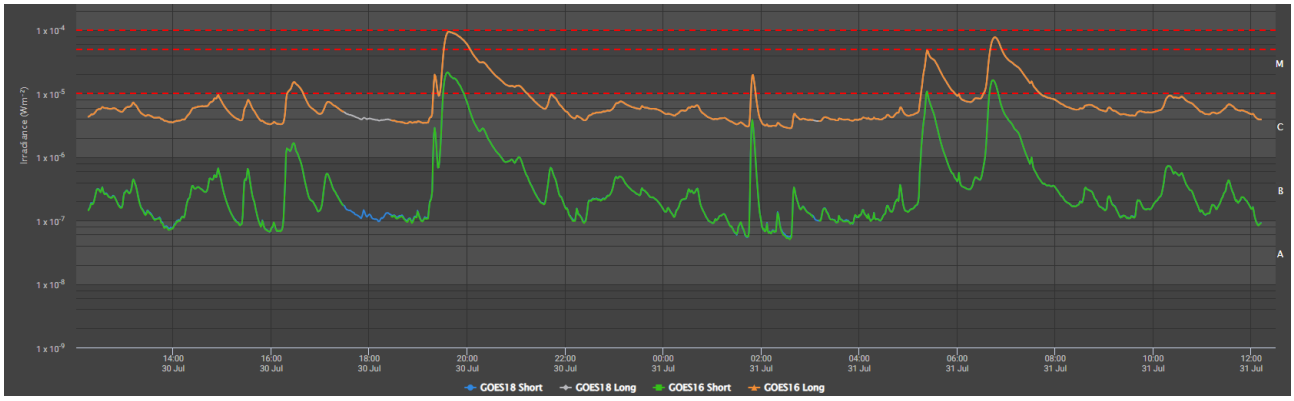
Radio Blackouts - X-Ray Flares:

High to Moderate activity is forecast, with occasional M-class flares expected and a chance of further isolated X-class flares given the large number of complex active region currently on the disk and activity over recent days.

Newly numbered AR3772 in the southeast and a large as yet unnumbered region rounding the east limb have also been the source of M-class activity in recent hours. AR3772, or perhaps more likely the as yet unnumbered region, are likely the source of recent large far-sided events, with further complexity expected to become apparent as they rotate further into view. Far-side sounding data also suggests the potential for further large oncoming regions later in the period. Therefore The flare risk has been maintained throughout, with oncoming regions balancing the gradual loss of flare risk from the large cluster in the southwest as they increasingly approach the limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	90	90	90	90
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 3: Latest 24hr GOES16/18 X-Ray Flux trace.



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18 is currently is currently at background but has the potential to see rises in response to any notable flares on the disc, with a number of moderately sized and complex sunspots now into the western hemisphere and moving into an increasingly favorable position to give proton enhancement given any significant flare activity. This brings a chance of reaching the S1 Minor Radiation Storm level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	25	25	25
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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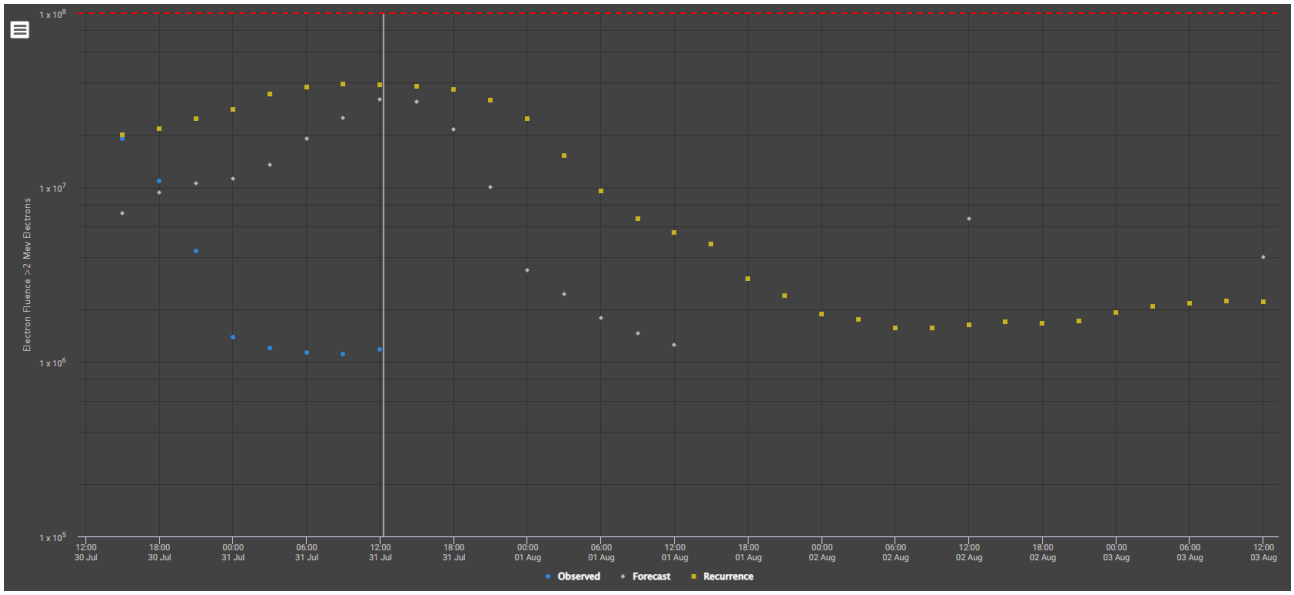
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16, is currently at background levels after being suppressed by the CME arrival late on 29 July. Further CME arrivals are anticipated to keep the observed flux at background, but may allow for a re-enhancement once any CME influence recedes, with Moderate flux possible through the diurnal peak Days 3-4 (02-03 Aug). The associated 24hr electron fluence is expected to remain below Active. MOSWOC REFM is currently providing a reasonable guide, but confidence becomes increasingly low into the period given uncertainties in CME influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output.



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